THE FIRST ADULT OF *SPINADIS* (EPHEMEROPTERA: HEPTAGENIIDAE)[1,2]

W. P. McCafferty, A. V. Provonsha[3]

ABSTRACT: An adult female of the aberrant mayfly genus *Spinadis* was reared from a larva collected from the White River, Indiana. Head, prothoracic, hind wing, and hing leg characters are of particular diagnostic value and may be applicable to the adult male also. Comparisons with all other genera of Heptageniidae revealed that in detail, the adult is as unusual for the family as is the larva. Its closest generic affinity is with *Anepeorus*. Both sexes of adults of the light-colored sympatric heptageniids *Macdunnoa persimplex*, *Nixe flowersi*, *Stenomena integrum*, and *Anepeorus simplex* should be distinguishable from *Spinadis*. A relatively small number of eggs were contained in the female.

The unusual and distinctive North American genus *Spinadis* was described by Edmunds and Jensen (1974) on the basis of small samples of larvae taken in 1973 and 1974, by different workers, from the Altamaha River, Georgia, the Wisconsin River, Wisconsin, and the White River, Indiana. One of the Indiana larvae collected by us was illustrated by Edmunds et al. (1976). The sudden and independent discoveries of this previously unknown mayfly from three disjunct locations in the eastern half of the U.S. is probably attributable to the increased emphasis on large river surveys and water quality studies during the 1970's.

We have continued to search comprehensively for additional larvae of *Spinadis* in the White River, but have been able to collect only one or two specimens at a time. Each time the larvae have been taken from different habitats and substrates of driftwood, gravel, and silt-sand. Since other collections of larval *Spinadis* have been as drift, including the most recently reported collection by Sanders and Bingham (1981) from the lower Mississippi River, the exact microhabitat of *Spinadis* remains unknown. Its scarcity in collections is, however, typical of some other "big river" mayflies. The most obvious comparison is with *Anepeorus* in the Midwest, which also happens to be an aberrant, carnivorous heptageniid. These similarities, although evidently considered fortuitous ecological parallelisms by certain workers, may possibly reflect some phyletic relationships as will be discussed below.

Spinadis is so strickingly unusual as a larva that Edmunds and Jensen (1974) erected an exclusive subfamily of Heptageniidae, Spinadinae, for it. They also indicated that, except for incipient wing venation apparent in larvae, it would be difficult to place these mayflies to family. The adult

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[2]Purdue Agricultural Experiment Station Journal No. 9852.

[3]Dept. of Entomology, Purdue University, West Lafayette, IN 47907.

stage, when discovered, would seemingly resolve questions about relationships of this genus, and thus we have assiduously attempted to rear it.

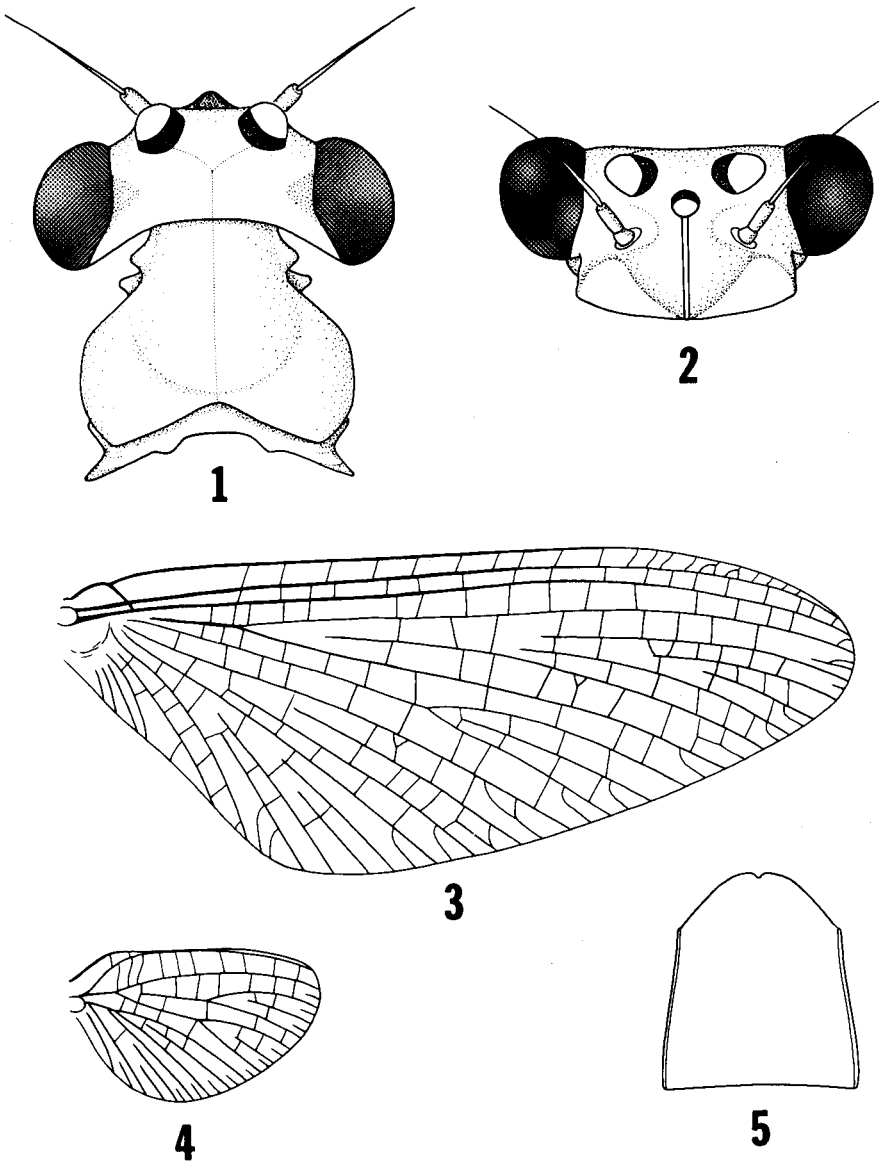
In 1982, we succeeded in rearing one adult female in our laboratory. Because it is very difficult to secure live larvae for rearing, and because our past experiences make us less than optimistic about rearing males in the near future, we now make the description of this female available. We do this cognizant that historically females of Heptageniidae have not yielded many reliable taxonomic characters; however, it appears that many times females are not studied closely by workers simply because of this reputation and so useful characters often are missed. In any case, a description may lead to further recognition of adults, including males, that may be unnoticed or misidentified, and any clues to the relationships of this anomalous taxon would appear justified. The described female is only tentatively assignable to the species *S. wallacei* Edmunds and Jensen, the only species described in the genus, and the following description and comparisons involve primarily generic rather than specific characterization.

Description

Adult female. Body 10.55 mm, white and unmarked except for charcoal bases of ocelli and very faint penciling appearing on some thoracic ridges. Compound eyes light, unicolorous externally, each with dark internal nucleus, dorsal median margins of eyes parallel in anterior half (Fig. 1); frontal shelf of head (Fig. 2) produced ventrally below level of eyes, truncate (ventral margin more-or-less straight) with well-developed ventro-lateral areas, unnotched medially along ventral margin. Prothorax (Fig. 1) large, broadly triangular; cervical region narrow and with two pairs of lateral obtuse projections as seen in dorsal view; posterior pair of projections representing more ventral supracoxal flanges; longitudinal midline of sclerotized pronotum ca. 1.75 x dorsal midlength of head. Fore legs 6.3 mm; tarsus .31 x tibia length; tibia 1.32 x femur length. Hind legs 6.1 mm, .58 x body length; tibia 1.16 x femur length; tarsus .33 x femur length, .29 x tibia length. Fore wings (Fig. 3) 9 mm; membrane transparent and unpigmented except stigmatic area translucent; longitudinal veins white; crossveins white and numerous; basal costal crossveins developed, attached, and straight to nearly straight; stigmatic crossveins not forming cellules, not anastomosed, slightly curving, some forked; bullar crossveins not crowded; MA symmetrically forked; base of MP_2 attached to MP_1 by crossvein; two pairs of cubital intercalaries between CuA and CuP, veins of second pair subequal in length. Hind wings (Fig. 4) 3 mm, .33 x fore wing length; costal projection reduced and rounded; membrane transparent and unpigmented: longitudinal veins and crossveins white; short, unattached intercalaries present in almost all major-vein interspaces; Rs forks attached to stem; MA forked; three intercalaries (one short, two long) between CuA and CuP. Subanal plate (Fig. 5) roundly produced posteriorly, with small median notch on posterior margin. Cerci 11 mm, unmarked.

Egg and Fecundity. Eggs round and similar to those of *Ecdyonurus insignis* (Eaton) as described and figured by Koss and Edmunds (1974). Knob-terminated coiled attachment threads concentrated at one pole, and chorion tuberculate. Only 311 eggs were found contained in the female; no eggs had been lost; and they were located in abdominal segments 1-6. This is a relatively small number of eggs for a mayfly (Clifford and Boerger (1974).

Material Examined. Adult female in alcohol, reared, dissected, with a fore and hind wing dry



Figs. 1-5. *Spinadis* cf/*wallacei*, adult female. 1. Dorsal head and pronotum. 2. Head, facial view. 3. Fore wing. 4. Hind wing. 5. Subanal plate.

slide-mounted and some eggs mounted in Hoyer's. Indiana: Martin Co., West Fork White River at Hindostan Falls Public Fishing Site, VII-26-1982, A. V. Provonsha and M. Doub. Deposited in the Purdue Entomological Research Collections.

DISCUSSION

Several character states are of use in distinguishing the female adults of *Spinadis* from females of other heptageniid genera, particularly when characters are used in combination. Perhaps even more importantly, character states have been found that have good potential for diagnosing males as well because they involve characters that are not sexually dimorphic among other known Heptageniidae. The following comparisons should still be viewed as provisional since the study of only one adult specimen of *Spinadis* precludes any accounting of possible individual variability, although most characters examined were selected because they are not known to be particularly prone to vary. Also, because there remains a paucity of information on adult female morphology, our comparisons are based on what can be gleaned from the literature on foreign genera and the study of females in our possession, which are limited to North American genera.

Two characters of the head appear to be of diagnostic value. The ventral margin of the frontal shelf (Fig. 2) is quadrately produced. We have not seen this exact character state in other Heptageniidae females, where instead there tends to be a medial production only and often a small notch or emargination on this ventrally produced region. If this facial character state is consistent for males (the ventral margin is not affected by sex in adults we have examined) it would either be similarly produced in the male of *Spinadis* if the male eyes exhibit primarily a dorsally oriented enlargement, as is the case in most genera, or it would at least appear as an unproduced, more-or-less straight margin between the eyes if the male eyes exhibit ventral enlargement, as is the case with some *Anepeorus*. Such an unproduced, straight margin is found in *Anepeorus, Pseudiron,* and possibly *Rhithrogeniella* (Ulmer 1939). The medial dorsal margins of the compound eyes (Fig. 1) are parallel with each other in the anterior half. In other female heptageniids we have examined, these margins are distinctly convergent posteriorly.

The relatively large prothorax of *Spinadis* (Fig. 1) appears to be of diagnostic value. In other heptageniid adults we know, including both males and females, the longitudinal midline of the pronotum is rarely much longer than the dorsal midlength of the head. In *Spinadis* it is nearly twice as long. Also, the posterior margin of the pronotum of *Spinadis* is not as deeply emarginate as in other genera (except *Anepeorus*), and the lateral projections in the cervical region are quite possibly unique. We cautiously

presume that the male of *Spinadis* will exhibit a similar relative size of the prothorax, although we are aware of sexually dimorphic pronota in the palingeniid genus *Pentagenia* (McCafferty 1972). In examining this character care should be taken so that only sclerotized terga are measured. If the head or prothorax is pulled or telescoped, intersegmental membranous integument will appear between the head and pronotum and between the pronotum and mesonotum and possibly obscure length measurements.

Fore wing venation (Fig. 3) reveals no features that would be of value in distinguishing *Spinadis* from most other heptageniid genera, being describable as generalized for the family. The hind wing (Fig. 4), however, may be of some value for this purpose and should apply to males as well as females. There are three cubital intercalaries present, but at least eight other heptageniid genera can possess this number. North American genera that notably vary from this are *Leucrocuta* and *Nixe* (Flowers 1980), *Macdunnoa* (Flowers 1982), *Cinygma, Arthroplea,* and *Anepeorus.* The costal projection of the hind wing of *Spinadis* is very reduced and rounded. A similar costal projection is found in *Pseudiron* and *Anepeorus.* Other heptageniid hind wings exhibit an acute, subacute, or obtuse costal projection.

Fore leg segment proportions of adult female Heptageniidae genera are poorly known. Nevertheless, at least some valid diagnostic comparisons can be drawn with females of certain other North American genera. The fore tibia of *Spinadis* is atypically long relative to both the fore tarsus and the fore femur (it is approximately three times the length of the tarsus and one and one-third the length of the femur). As far as we know, only some *Rhithrogena* and possibly some *Epeorus* females (Traver 1935) approach these proportions. In most other genera the fore tarsus is almost as long as or longer than the tibia, and the tibia is seldom as long as or much longer than the femur. These characters require further study, and they are not usable for adult males.

Traver (1935) described the adult hind legs of several heptageniid genera and indicated that the characteristics applied to both males and females. We have also compared hind legs of many genera and found that character states dealing with segment proportions are consistent between sexes. It is therefore likely that the hind legs of *Spinadis* will prove to be highly valuable since they are essentially different from other genera. The hind tibia is relatively long, and the tarsus is relatively short, and these are also somewhat indicated in the larva of *Spinadis.* The adult hind tibia is 1.16 times the hind femur length. Only in the Asian genus *Bleptus* (Eaton 1885) is the hind tibia found that is as long as this (actually longer) in comparison to the femur. In North America, some *Epeorus, Rhithrogena,* and *Macdunnoa* have a tibia that is subequal to the femur. All other genera and other members of the latter three genera have a tibia that is shorter than

the femur to various degrees. The hind tarsus of *Spinadis* is .29 times the hind tibia length. Some *Ironodes* and *Epeorus* exhibit the same proportions, and the hind tarsus of *Bleptus* (Eaton 1885), *Rhithrogena, Heptagenia,* and *Afronurus* (Schoonbee 1968) very closely approach this tarsus to tibia relationship. Other genera have a hind tarsus that ranges anywhere from .4 to 1.4 (greatest in *Pseudiron*) times the hind tibia length.

The shape of the subanal plate of the female was used to key groups of heptageniid genera by Edmunds et al. (1976). Its value remains questionable, however, because it is highly variable in some genera such as *Stenonema* (Bednarik and McCafferty 1979). The subanal plate (Fig. 5) of *Spinadis* is similar to those of some *Epeorus* and *Stenonema.*

Spinadis females should be distinguishable from other unmarked and relatively unpigmented females of heptageniid species that are found sympatrically from midwestern and eastern North America in the vicinity of larger rivers. These species include *Macdunnoa persimplex* (McDunnough), *Stenonema integrum* (McDunnough), *Nixe flowersi* McCafferty (see respectively Flowers 1982, Bednarik and McCafferty 1979, and McCafferty 1982 for treatments of these species), and presumably *Anepeorus simplex* (Walsh). *Spinadis* may be longer in body length than these species by as much as 4 mm, the hind tibia of *Spinadis* is proportionately longer, and the prothorax is proportionately larger in *Spinadis.* The costal projection of the hind wing, shape of the frontal shelf of the head, and the dorsal margination of the eyes should allow further discrimination between *Spinadis* and *Stenonema, Macdunnoa,* and *Nixe.*

Although only males of *Anepeorus* and females of *Spinadis* can presently be compared, there are some basic similarities. General wing venation, shape of the costal projection of the hind wing, and hind tarsus to hind tibia ratio are quite similar in the two genera. The ventral margin of the frontal shelf of the head, margination of the eyes dorsally, and general shape of the pronotum are similar in *Spinadis* and *A. simplex.* The macrohabitat, carnivorous habit, and gill structure of the larvae of the two genera are also similar. All these data suggest some relationship between the two genera (and subfamilies), particularly since many of these characteristics are not found in other heptageniids. Edmunds and Jensen (1974) did not feel that the two were closely related based on knowledge of larvae only. This possible relationship should now be reevaluated.

From adult morphology, *Spinadis* appears more closely related (at least phenetically) to *Anepeorus* than any other genus, although admittedly there are many aberrant structural differences between the larvae. (If the involved shared adult traits are of a primitive nature relative to the Heptageniidae they will not yield pertinent phyletic information.) Adult characteristics indicate a lesser affinity with *Pseudiron,* another unusual North American genus that has been placed in its own subfamily. The

larvae of *Spinadis* lack the median terminal filament as do those of *Belptus* (Ueno 1931), *Ironodes,* and *Epeorus.* Adult hind leg character states are also similar in these genera, and some relationship among these four genera may also be indicated. Character state polarity in adult heptageniids needs to be reasonably understood before synapomorphies can be determined and the relative phyletic position of *Spinadis* theorized.

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